

(3) *Long-term and secondary effects.* The following effects shall be addressed, as appropriate, for the planned platform:

- (i) Local vibration due to machinery, equipment, and vortex shedding;
- (ii) Stress concentrations at critical joints;
- (iii) Secondary stresses induced by large deflections (P-Δ effects);
- (iv) Cumulative fatigue;
- (v) Corrosion;
- (vi) Marine growth; and
- (vii) Ice abrasion.

(4) *General arrangement.* The platform and equipment shall be arranged to minimize the potential of structural damage and personal injury resulting from accidents. In this regard, the consequences of the arrangement or placement of the following components and their effects shall be addressed:

- (i) Equipment and machinery—noise and vibration,
- (ii) High-pressure piping—leakage in closed spaces,
- (iii) Lifting devices—dropped loads, and
- (iv) Vessel mooring devices—line breakage and tripping quick-release mechanisms.

(5) *Corrosion-protection zones.* Measures taken to mitigate the effects of corrosion as required by §§ 250.907(d) and 250.908(c)(5) of this part shall be specified and described in terms of the following definitions for corrosion-protection zones:

- (i) Submerged zone—that part of the platform below the splash zone,
- (ii) Splash zone—that part of the platform between the highest and lowest water levels reached by sea states exceeded for 1 percent of the time annually when superimposed on the highest and lowest levels of tide with due allowance for high and low installation of the platform,
- (iii) Atmospheric zone—that part of the platform above the splash zone,
- (iv) Ice zone—that part of the platform which can reasonably be expected to come into contact with floating or submerged ice annually.

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§ 250.907 Steel platforms.

(a) *Materials*—(1) *General.* (i) This section covers specifications for materials used for the construction of steel pile-supported platforms. Steels shall be suitable for their intended service as demonstrated by testing under relevant service conditions or previous satisfactory performance under service conditions similar to those intended. Steels shall be of good commercial quality, defined by specification, and free of injurious defects.

(ii) Steels shall exhibit satisfactory formability and weldability characteristics and fracture toughness satisfactory for the intended applications. Materials for structural members which are fracture critical or for members which sustain significant tensile stress and whose fracture would pose a threat to the survival of the platform shall have sufficient toughness to guard against brittle fracture. Materials selected for members which are subjected to significant tensile stress shall have toughness suitable to their intended application.

(iii) In cases where principal loads from either service or weld residual stresses are imposed normal to the plate, appropriate precautions shall be taken to avoid lamellar tearing parallel to the plate surface.

(2) Material selection information including the following:

(i) Steels for structural members shall be selected according to criteria that take into account the required yield strength, fracture toughness, service temperature (see paragraph (a)(3) of this section), and intended application;

(ii) Bolts and nuts shall have mechanical and corrosion properties comparable to the structural elements being joined. Materials for bolts and nuts shall be defined by and tested in accordance with material standards compatible with those for the joined structural members;

(iii) When new alloys are used, the adequacy of fracture toughness shall be supported by appropriate fracture tests; and

(iv) When materials other than steel are used for structural purposes, the mechanical and durability properties necessary for their intended function

shall be designated, including toughness and fatigue characteristics, where necessary.

(3) *Service temperature.* Service temperature means the temperature that the material is expected to achieve in the operational environment.

(i) For material at or below the waterline, the minimum service temperature shall be the lowest average daily water temperature applicable to the particular depth. For material above the waterline, the minimum service temperature shall be the lowest 1-day average daily atmospheric temperature over a 10-year period, unless the material is warmed by auxiliary heating.

(ii) In all cases where material temperature is reduced by localized cryogenic storage or other cooling means, such factors shall be accounted for in establishing minimum service temperature.

(4) *Classification of applications.* When considering the welding requirements given in subsequent sections, materials shall be considered as "Weld Class A" if the members are critical or special structural elements, "Weld Class B" if the members are primary load-carrying members of the platform, or "Weld Class C" if the members are secondary structural elements.

(5) *Material designation.* All material employed in platform construction shall be described and designated by a material specification.

(b) *Fabrication and welding—(1) General.* (i) Welding shall be performed in accordance with the applicable provisions of the American Welding Society (AWS) publication, AWS D1.1, Structural Welding Code—Steel, or other appropriate welding codes.

(ii) Fabrication other than welding shall be performed in accordance with American Institute of Steel Construction (AISC) publication, Specification for Structural Steel Buildings, Allowable Stress Design and Plastic Design, or other appropriate codes. The code to be followed during fabrication and construction shall be specified on design documents.

(2) *Welding.* (i) Welding procedures and filler metals shall be selected to produce sound welds, and the filler metal shall have strength and toughness compatible with the base metal.

Workmanship shall be in compliance with paragraph (b)(1)(i) of this section.

(ii) Forming processes shall not degrade the base metals below their minimum required properties. A heat treatment shall be employed to provide the required properties, where necessary.

(iii) Misalignment between parallel (abutting) members shall be minimized. Weld size for fillet welds shall be sufficient to compensate for the gap between faying surfaces of the members. Lapped joints shall possess sufficient overlaps. Both edges of an overlap joint shall have continuous fillet welds.

(iv) When arc-air gouging is employed, the carbon buildup and burning of the weld or base metals shall be minimized.

(v) Peening shall not be used for single-pass welds or for the root or cover passes of multipass welds. Peening shall be used only after cleaning of weld passes. Fairing by heating, flame shrinking, or other methods, when applied to Weld Class A or B structural elements, shall be performed without damaging the base metals. Such corrective measures shall be kept to a minimum when treating high-strength steels.

(3) *Quality assurance.* A documented inspection plan shall be prepared and followed and shall cover the following items:

(i) A suitable system for material identification and quality control during all stages of construction,

(ii) Requirements for welding procedures and welder qualifications,

(iii) The extent of weld inspection (including nondestructive examination methods) and the criteria for weld acceptance or rejection, and

(iv) Necessary dimensional tolerances.

(4) *Weld nondestructive examination.* (i) All welds shall be subjected to visual examination. Nondestructive examination shall be conducted to the extent indicated in paragraph (b)(4)(ii) of this section after all forming and postweld heat treatments have been completed. Weld examination procedures shall be adequate to detect delayed weld cracking in cases involving high-strength

steels or high-hydrogen welding processes.

(ii) As called for in paragraph (b)(3)(iii) of this section, a plan for non-destructive examination of the welds shall be prepared and followed. The extent of inspection of Weld Classes A and B structural elements shall be consistent with the applications involved. Important welds of Weld Classes A and B structural elements are those inaccessible or very difficult to inspect in service. Important welds shall be subjected to an increased level of non-destructive examination during fabrication.

(iii) If the proportion of unacceptable welds becomes excessive, the frequency of nondestructive examination shall be increased.

(c) *Design and analysis*—(1) *General*. (i) Steel platforms shall be adequately designed and analyzed to withstand the loads to which they are likely to be exposed during their design life. The effects on the platform shall be determined for a minimum set of loading conditions by using a defensible method to ensure that the resulting responses do not exceed the safety criteria appropriate to the methods employed.

(ii) The use of design methods, other than those specifically covered in this section, and their associated safety criteria are allowed if it can be demonstrated that such alternative methods will result in a structural safety level equivalent to that provided by the direct application of these requirements.

(iii) Sections 250.905 and 250.906 of this part shall be consulted regarding definitions and requirements pertinent to the determination of loads and general design requirements.

(2) *Loading conditions*. (i) Appropriate loading conditions that produce the most adverse effects on the platform during and after fabrication and installation shall be considered;

(ii) Loadings corresponding to conditions after installation shall include at least those relating to both the operating and design environmental conditions, combined with other pertinent loads in the following manner:

(A) Operating environmental conditions combined with dead and live

loads appropriate to the function and operation of the platform;

(B) Design environmental conditions combined with dead and live loads appropriate to the function and operation of the platform;

(C) Design environmental conditions combined with dead loads and minimum live loads appropriate to the function and operation of the platform; and

(iii) For platforms located in seismically active areas, loads induced by earthquake ground motions shall be combined with dead and live loads appropriate to the operation and function of the platform.

(3) *Methods of design and analysis*. (i) The nature of loads and loading combinations as well as the local environmental conditions shall be considered in the selection of design methods. Methods of analysis and their associated assumptions shall be compatible with the overall design principles.

(ii) Linear, elastic methods (working stress methods) of design and analysis are acceptable if proper measures are taken to prevent general and local buckling failure. Regarding structural instability as a possible mode of failure, the effects of initial stresses and geometric imperfection shall be taken into account.

(iii) Dynamic effects shall be accounted for if the wave energy in the frequency range of the structural resonance frequencies is of sufficient magnitude to produce significant stresses in the platform. The determination of dynamic effects shall be accomplished either by computing the dynamic amplification effects in conjunction with a deterministic analysis or by a random dynamic analysis based on a spectral formulation. In the latter case, the analysis shall be accompanied by a statistical description and evaluation of the relevant input parameters.

(iv) The interaction of the soil with the platform's piles shall be included in the analytical model used to obtain the structural response (see § 250.909(d)(1)(ii) of this part).

(v) For static loads, plastic methods of design and analysis shall be employed only when the properties of the steel and the connections exclude the possibility of brittle fracture and allow

for formation of plastic hinges with sufficient plastic rotation capacity and adequate fatigue resistance.

(vi) Whenever plastic analysis is used, it shall be demonstrated that the collapse mode (mechanism) corresponding to the smallest loading intensities has been used for the determination of the ultimate strength of the platform. The effect of buckling and other destabilizing nonlinear effects shall be taken into account in the plastic analysis of platforms with compressive forces. Whenever nonmonotonic or repeating loads are present, it shall be demonstrated that the structure will not fail by incremental collapse or fatigue.

(vii) Under dynamic loads when plastic strains may occur, the considerations specified in paragraph (c)(3)(v) of this section shall be satisfied and any buckling and destabilizing nonlinear effects shall be taken into account.

(4) Allowable stresses and load factors.

(i) When the design is based on a working-stress method (see paragraphs (c)(1)(ii) and (c)(3)(ii) of this section), the safety criteria shall be expressed in terms of appropriate basic allowable stresses in accordance with requirements specified in paragraphs (c)(4) (ii) through (vi) of this section.

(ii) For structural members and loadings covered by AISC publication, Specification for Structural Steel Buildings, Allowable Stress Design and Plastic Design, with the exception of earthquake loadings (see paragraph (c)(4)(v) of this section) and tubular structural members under the combined loading of axial compression and bending, the basic allowable stresses of the members shall be obtained using the AISC specification. For tubular members subjected to the aforementioned interaction, stress limits shall be set in accordance with a defensible formulation.

(iii) Where stresses in members listed in paragraph (c)(4)(ii) of this section are shown to result from forces imposed by the design environmental conditions acting alone or in combination with dead and live loads (see paragraph (c)(2)(ii) of this section), the basic allowable stresses cited in paragraph (c)(4)(ii) of this section, modified by a

factor of four-thirds, are permitted for the design environmental load contribution if the resulting structural member sizes are not less than those required for dead and live loads plus operating environmental conditions without the one-third increase in allowable stresses.

(iv) For any two- or three-dimensional stress fields within the scope of the working-stress formulation, the equivalent stress (e.g., the von Mises stress intensity) shall be limited by an appropriate allowable stress less than the yield stress, with the exception of stresses of a highly localized nature. In the latter case, local yielding of the structure is acceptable if it can be demonstrated that such yielding does not lead to progressive collapse of the overall platform and that the general structural stability can be maintained.

(v) When considering loading combinations on individual members or on the overall platform, which include loads defined as accidental (see § 250.905(c)(4) of this part), or in pursuing structural analysis for earthquake loads (see paragraph (c)(2)(iii) of this section), the allowable stress set at a level of the minimum yield or buckling strength of the material shall be considered appropriate.

(vi) Whenever elastic instability, overall or local, may occur before the compressive stresses reach the minimum specified yield strength of the material, appropriate allowable buckling stresses shall govern.

(vii) Whenever the ultimate strength of the platform is used as the basis for the design of its members, the safety factors or the factored loads shall be formulated in accordance with the requirements of AISC publication, Specification for Structural Steel Buildings, Allowable Stress Design and Plastic Design, or an equivalent code. The capability of the primary structural members to develop their predicted ultimate load capacity shall be demonstrated.

(viii) For details of high-stress concentration, consideration shall be given to safety against brittle fracture and to material quality-control procedures.

(5) *Structural response to earthquake loads.* (i) Platforms located in seismically active areas shall be designed to possess adequate strength and stiffness to withstand the effects of an earthquake which has a reasonable likelihood of not being exceeded during the lifetime of the structure (see paragraph (c)(2)(iii) of this section) and remain stable during rare motions of greater severity;

(ii) The adequacy of structural strength shall be demonstrated by analysis to verify that no significant structural damage occurs; and

(iii) Platforms shall also possess adequate ductility to withstand a rare intense earthquake.

(6) *Fatigue assessment.* (i) Structural members and joints for which fatigue is a probable mode of failure and for which past experiences are insufficient to ensure safety from possible cumulative fatigue damage shall be analyzed. Emphasis shall be given to joints and members in the splash zone, those that are difficult to inspect and repair after the platform is in service, and those susceptible to corrosion-accelerated fatigue, and

(ii) For structural members and joints which require a detailed analysis of cumulative fatigue damage, the results of the analysis shall indicate a minimum calculated life of twice the design life (see § 250.906(c)(1) of this part) of the platform if there is sufficient structural redundancy to prevent catastrophic failure of the platform as a result of fatigue failure of the member or joint under consideration. If such redundancy does not exist or if the desirable degree of redundancy is significantly reduced as a result of fatigue damages, the results of a fatigue analysis shall indicate a minimum calculated life of three times the design life of the platform.

(d) *Corrosion protection.* All materials shall be protected from the effects of corrosion by a corrosion-protection system. The design of such systems shall take into account the possible existence of stress corrosion, corrosion fatigue, and galvanic corrosion. If the intended sea environment contains unusual contaminants, any special corrosive effects of such contaminants shall also be considered. Protection systems

shall be designed in accordance with the National Association of Corrosion Engineers (NACE) publication, NACE Standard RP-01-76, Recommended Practice, Corrosion Control of Steel, Fixed Offshore Platforms Associated With Petroleum Production, or other comparable standards.

(e) *Connection of piles to structure.* The attachment of the jacket structure to the piles shall be accomplished by positive, controlled means. Such attachments shall be capable of withstanding the static and long-term cyclic loadings to which they will be subjected.

[53 FR 10690, Apr. 1, 1988; 53 FR 26067, July 11, 1988, as amended at 61 FR 60025, Nov. 26, 1996. Redesignated and amended at 63 FR 29479, 29486, May 29, 1998]

§ 250.908 Concrete-gravity platforms.

(a) *General.* (1) This section covers the materials, analysis, design, and construction of reinforced and/or prestressed concrete-gravity platforms.

(2) Materials, structural systems, methods of design, and methods of construction that do not conform to the requirements of this section shall not be used unless it is shown that they will result in a safety level at least equivalent to that provided by the direct application of the requirements of this section.

(b) *Materials*—(1) *General.* All materials shall be selected with due attention to their strength and durability in the marine environment. All material tests shall be performed in accordance with the latest, applicable standards of the American Society for Testing and Materials (ASTM).

(2) *Cement.* (i) Cement must be equivalent to Type I, II, or III portland cement as specified by ASTM Standard C 150-99, Standard Specification for Portland Cement, or portland-pozzolan cement as specified by ASTM Standard C 595-98, Standard Specification for Blended Hydraulic Cements. However, the suitability of Type III cement to serve its intended function must be demonstrated.

(ii) The tricalcium aluminate content of the cement shall be such as to enhance the corrosion protection of reinforcing steel without impairing the durability of concrete.